INDOOR AIR QUALITY ASSESSMENT

McCall Middle School
263 Main Street
Winchester, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of a parent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding potential indoor air quality concerns at the McCall Middle School, Winchester, MA. On February 4, 2003 a visit was made to the school by Cory Holmes, Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, to conduct an assessment. Mr. Holmes was accompanied by Shawn Sullivan, Environmental Analyst of BEHA's ER/IAQ program and Dan Doucette, Head Custodian.

The school is a four-story brick structure with a basement built in the early 1930's. An addition was built in 1950. The school underwent renovations in 2000 with the construction of a new addition. The school contains general classrooms, science classrooms, a music room, computer labs, several resource rooms, an auditorium, a library-media center, gymnasium, a band room, office space, several art rooms, technology labs, a sewing room, kitchen, cafeteria and a youth center. Windows throughout the building are openable.

In January of 2002 several students and a teacher experienced symptoms of dizziness and nausea, one student was reported to have fainted. School and health officials believed the symptoms to be related to potential entrainment of exhaust emissions related to idling delivery vehicles. As a result school Principal Evander French, Jr. directed vendors (in a letter) to follow the listed procedures:

- No deliveries should be made prior to 7:00 a.m., as mandated by the Town Manager.

- Vehicles should park as close as possible to the loading dock to minimize potential entrainment by fresh air intakes.
- Vehicle operators must turn off engines when conducting deliveries.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school houses students grades 6-8. It has a student population of approximately 870 and a staff of approximately 100. Tests were taken during normal operations at the school and results appear in Tables 1-4. No measurable levels of carbon dioxide were detected during the assessment.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in four of thirty-two areas surveyed, indicating adequate ventilation in most areas of the school. Fresh air in classrooms is supplied by a unit ventilator (univent) system. Classroom temperature and airflow is controlled by a centralized computer system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 1) and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed,

filtered, heated and distributed to classrooms through a fresh air diffuser located in the top of the unit. Univents were found deactivated or obstructed in a number of classrooms (see Tables/Picture 2), which can prevent airflow and lead to increased carbon dioxide levels. In order for univents to provide fresh air as designed, they must remain free of obstructions and allowed to operate.

The mechanical exhaust ventilation system in classrooms consists of grated, wall or ceiling-mounted exhaust vents (see Picture 3). Exhaust air is expelled from the building by a motorized exhaust vent located on the roof (see Picture 4). These vents were operating throughout the building.

Mechanical ventilation in common areas such as the cafeteria, gymnasium and auditorium are provided by air handling units (AHUs). As with the univent system, AHUs are controlled from a central computer terminal.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993; SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and

maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements ranged from 71^{o} F to 74^{o} F, which were within the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 26 to 31 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Signs of bird roosting and nesting materials were observed in the intake louvers of two univents (see Picture 5). These observations were verbally reported to Mr. Doucette and school principal Evander French on the day of the assessment. Mr. Doucette stated that the nests would be removed that day. BEHA staff recommended that the units be inspected for signs of bird wastes and thoroughly cleaned and disinfected as needed. Birds can be a source of disease, and bird wastes and feathers can contain mold and mildew, which can be irritating to the respiratory system. No obvious signs of bird roosting inside the building were noted by BEHA staff nor reported by occupants.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be sources of mold growth. Plants are also a source of pollen. Plants in several classrooms were noted near univent air diffusers (see Picture 6-8). In some classrooms, plant debris and potting soil were seen on/inside univent air diffusers. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Along the perimeter of the building, shrubbery was growing in close proximity to univent air intakes (see Picture 9). Care should be taken to ensure that fresh air intakes remain clear of obstructions (e.g. shrubbery) to avoid the entrainment of dirt, moisture, pollen and/or other particulate matter.

Other Concerns

Several other conditions that can potentially affect indoor air quality were also identified. The art room contained a small jewelry kiln on a countertop (see Picture 10). No local exhaust ventilation appears to be provided for this equipment. Pottery kilns can produce carbon monoxide and sulfur dioxide, which can cause respiratory symptoms in exposed individuals. This area does however contain several pottery kilns that are equipped with local exhaust ventilation, located in an adjacent room (see Picture 11). BEHA staff recommended that the jewelry kiln be relocated to utilize local exhaust provided for the pottery kilns. This material can be easily aerosolized and serve as eye and respiratory irritants.

In addition, many rooms contain dry erase boards, markers and cleaners. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs) (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also be irritating to the eyes, nose and throat.

Finally, in an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (see Picture 12). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and to off-gas VOCs. Tennis balls are made with a natural rubber latex

bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix II (NIOSH, 1998).

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Develop a clear line of communication between the central maintenance department and school personnel for prompt remediation of temperature and/or ventilation concerns/complaints. Classroom occupants should report temperature extremes immediately to school administration/maintenance and refrain from deactivating equipment.
2. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation *operate continuously* during periods of school occupancy.
3. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.
4. Remove all blockages from univents to ensure adequate airflow. Clean out interiors of univents regularly.

5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
6. Remove plants from univents. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
7. Consider discontinue the use of tennis balls on chairs to prevent latex dust generation.
8. Relocate jewelry kiln in art room to utilize local exhaust ventilation for pottery kilns (see Picture 11).
9. Remove bird's nests from univent air intakes. Inspect to ensure surfaces are free of nesting materials and bird wastes. Clean and disinfect with an appropriate antimicrobial where necessary.
10. Trim plant growth away from air intakes to avoid the entrainment of moisture, pollen and mold.
11. In order to provide self assessment and maintain a good indoor air quality environment on your building, consideration should be give to adopting the US

EPA document, “Tools for Schools”, which can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.

12. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH’s website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

NIOSH. 1998. Latex Allergy A Prevention. National Institute for Occupational Safety and Health, Atlanta, GA.

NIOSH. 1997. NIOSH Alert Preventing Allergic Reactions to Natural Rubber latex in the Workplace. National Institute for Occupational Safety and Health, Atlanta, GA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBAA. 2001. Latex In the Home And Community Updated Spring 2001. Spina Bifida Association of America, Washington, DC. Http://www.sbaa.org/html/sbaa_mlatex.html

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1

Univent Air Intake

Picture 2

Classroom Items on Univent Air Diffuser

Picture 3

Classroom Exhaust Vent

Picture 4

Rooftop Exhaust Motors, Note Melted Snow Indicating Operation

Picture 5

Flowering Plants on/near Classroom Univent

Picture 6

Hanging Plants above Univent Air Diffuser

Picture 7

Close-up of Standing Water/Mold Growth in Drip Pan of Plant on Classroom Floor Near Univent Return Vent

Picture 8

Bird Nesting Materials in Univent Air Intake

Picture 9

Shrubbery in Close Proximity to Univent Air Intake

Picture 10

Small Jewelry Kiln

Picture 11

Local Exhaust Ventilation for Pottery Kiln

Picture 12

Tennis Balls on Chair Legs in Classroom

TABLE 1

Indoor Air Test Results – McCall Middle School, Winchester, Massachusetts– February 4, 2003

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	365	58	32					Overcast – cold CO = 0-2
Room A 302	769	71	30	1	Y	Y	Y	Occupants gone, CO = 0
Room A 312	851	71	30	0	Y	Y	Y	UV deactivated by occupant, pencil sharpener, CO = 0 2 CT, spray cleaning products
Music Room	608	71	27	18	Y	Y	Y	2 UV, CO = 0
Computer Room A 205	525	71	28	1	Y	Y	Y	25 occupants gone for 25 min., CO = 0
Room A 209	564	72	28	1	Y	Y	Y	Plants on UV, CO = 1 Door open
Room A 208	674	73	28	3	Y	Y	Y	CO = 0
Auditorium	493	72	26	30	N	Y	Y	CO = 0
Room A 212	742	72	28	12	Y	Y	Y	UV deactivated, cleaning products Door open, items/plants on UV

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles
UV – univent
CO – carbon monoxide in ppm*

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – McCall Middle School, Winchester, Massachusetts– February 4, 2003

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room C 212	781	73	28	13	Y	Y	Y	Items on vent, CO = 0
Room C 205	847	72	29	19	Y	Y	Y	CO = 0
Room C 209	678	72	28	19	Y	Y	Y	CO = 0
Room C 107	677	74	28	1	Y	Y	Y	CO = 0
Library	567	72	26	5	Y	Y	Y	20 to 25 occupants – gone for 5 min. CO = 0
Room D 107	512	72	28	14	Y	Y	Y	CO = 0
Room A 107	784	72	29	5	N	Y	Y	CO = 0
Gym	503	72	27	40	Y	Y	Y	CO = 0
Band Room	694	72	27	20	Y	Y	Y	Plants, CO = 0

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Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room A 119	741	73	28	5	Y	Y	Y	CO = 0
Cafeteria	934	73	31	200	Y	Y	Y	2 of 6 UV – on, CO = 0
AG 12	519	73	27	1	Y	Y	Y	18 occupants – gone 15 min., CO = 0
BG 22	927	72	30	18	Y	Y	Y	Door open, CO = 0
GB 25	570	72	28	21	Y	Y	Y	CO = 0
Cad Room	547	72	28	0	Y	Y	Y	CO = 0
BG 12	594	73	29	18	Y	Y	Y	Small jewelry kiln (Ele), CO = 0
Dark Room	635	73	29	0	N	Y	Y	Local exhaust, CO = 0
Kiln Room					N	Y	Y	Local exhaust-rooftop, CO = 0

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TABLE 4

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Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
BG 09	574	73	28	15	Y	Y	Y	Plants around/near UV, CO = 0
								CO = 0
Girls Locker Room	403	73	27	0	Y	Y	Y	Occupants – sewer gas odor, CO = 0
DB 08	732	72	29	20	Y	Y	Y	Items on UV, CO = 0
DB 02	731	72	29	23	Y	Y	Y	Items in from of UV return Hanging plant over UV, CO = 0
DB 04	472	71	29	16	Y	Y	Y	Door open, desk in front of UV return, plants, large plant in standing water near return, exhaust over hallway door, CO = 0
Youth Center	384	68	31	1	Y	Y	Y	CO = 0
Locker Room	379	72	31	0	N	Y	Y	

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